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(54) POLARIZING ELEMENT, OPTICAL ELEMENT, LIGHTING DEVICE, AND LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an optical element and a lighting device which can form the liquid crystal display device having superior luminance and field angle characteristics by obtaining the polarizing element which is superior in circular polarization dichroic performance, wide-band performance, and polarization degree and has superior alignment.

SOLUTION: This lighting device has a polarizing element 1 consisting of cholesteric liquid crystal layers 12, 13, and 14 of ≤5 μm in thickness and ≤10% in haze which are stacked one over another, the optical element consisting of a stack of one or more layers of the polarizing element, a 1/4 wavelength plate, and a field angle compensating plate or polarizing plate, and the polarizing element or optical element and a surface light source or a liquid crystal cell. Consequently, the thickness can easily be increased by the stacking system of the cholesteric liquid crystal layer having excellent alignment and the polarizing element 1 is obtained which has superior circular polarization dichroic performance, wide-band performance, polarization, and alignment and also has small discoloration due to variation in field angle.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] this invention relates to the suitable polarizing element for the improvement in brightness of a liquid crystal display etc., suppression of display nonuniformity, etc., the optical element using it, and a lighting system.
[0002]
Background of the Invention] The element which consists of a layered product of the cholesteric-liquid-crystal layer which shows the property to divide circular dichroism, i.e., the natural light, into the reflected light which consists of the circular polarization of light, and the transmitted light as a polarizing element in which the difficulty of the polarizing plate which the abbreviation half of an incident light is absorbed conventionally and serves as a loss is conquered, the brightness of a liquid crystal display is raised, and it deals, and 1/4 wavelength plate was known. This element changes into the linearly polarized light the circular polarization of light which has arranged it between the light source and a liquid crystal cell, and penetrated the cholesteric-liquid-crystal layer in 1/4 wavelength plate, makes a polarization shaft in agreement, carries out incidence of it to a polarizing plate, and prevents an absorption loss.
[0003] In the above, what superimposed two or more cholesteric-liquid-crystal layers from which the wavelength region of circular dichroism is different for the purpose of the wide-band-izing since the wavelength region which shows circular dichroism was narrow, and the thing which changed the spiral pitch in the thickness direction were known for the usual cholesteric-liquid-crystal layer (JP,1-133003,A, JP,6-281814,A).
[0004] Moreover, the stacking tendency of a cholesteric-liquid-crystal layer was raised, the suitable extensive viewing-angle property for a monitor etc. was given, and what gave condensing nature in the suitable check-by-looking direction for a notebook sized personal computer etc. (JP,9-287677,A, JP,9-293277,A, JP,9-314500,A, JP,9-314501,A), the thing which increased cholesteric-liquid-crystal layer thickness and raised the degree of polarization of circular dichroism were known (J. 8 Phys.D:Appl.Phys., 1975).
[0005] however, with the aforementioned conventional technology, when the thickness of a cholesteric-liquid-crystal layer was increased, for example for the purpose of wide-band-izing of circular dichroism, and improvement in degree of polarization, the problem to which a stacking tendency falls was produced, and there was a trouble with it difficult [to raise both the amount of preferred orientation and degree of polarization]
[0006]
[The technical technical problem of invention] this invention obtains the polarizing element which is excellent in the wide band nature and the degree of polarization of circular dichroism, and is moreover excellent in a stacking tendency, and makes a technical problem development of the optical element which can form the liquid crystal display which is excellent in brightness and a viewing-angle property, and a lighting system.

[0007]
[Means for Solving the Problem] Thickness is 5 micrometers or less and this invention offers the optical element characterized by the bird clapper from the layered product more than two-layer [of the polarizing element to which Hayes is characterized by the bird clapper from the superposition layer of 10% or less of cholesteric-liquid-crystal layer and the polarizing element and 1/4 wavelength plate, a viewing-angle compensating plate, or a polarizing plate / one layer or two-layer].
[0008] Moreover, this invention offers the lighting system characterized by having the liquid crystal display characterized by having a polarizing element or an aforementioned optical element, and an aforementioned liquid crystal cell and the aforementioned polarizing element, or an optical element above the surface light source, and the liquid crystal display characterized by having a liquid crystal cell in the optical outgoing radiation side of the lighting system.
[0009]
[Effect of the Invention] According to this invention, thickness can be easily increased with the superposition method of the cholesteric-liquid-crystal layer which is excellent in a stacking tendency, it can excel in the wide band nature, degree of polarization, and stacking tendency of circular dichroism, the color change by viewing-angle change can obtain a few polarizing element, and the optical element and lighting system which can form the liquid crystal display which is excellent in brightness and a viewing-angle property can be obtained using it.
[0010]
[The operation gestalt of invention] Thickness is 5 micrometers or less and, as for the polarizing element by this invention, Hayes consists of a superposition layer of 10% or less of cholesteric-liquid-crystal layer. The example was shown in drawing 1 and drawing 2 . 1 is a polarizing element, 12, 13, 14, and 15 are cholesteric-liquid-crystal layers, and 11 is a transparent base material as occasion demands. In addition, drawing 2 illustrates the optical element which comes to prepare 1/4 wavelength plate 2 on a polarizing element 1.
[0011] Thickness is 5 micrometers or less and Hayes of the cholesteric-liquid-crystal layer used for superposition is 10% or less of thing. Thereby, it shall excel in a stacking tendency. 4.5 micrometers or less of 1-4 micrometers of thickness are 2-3 micrometers above all, and Hayes of especially the cholesteric-liquid-crystal layer that can be used more preferably than points, such as a stacking tendency, is 5% or less of especially thing 8% or less above all 9% or less. When it applies to a liquid crystal display by considering as the polarizing element which is excellent in a stacking tendency combining 1/4 wavelength plate, brightness can be raised and a poor check by looking, such as display nonuniformity, can be suppressed.
[0012] Although cholesteric liquid crystal shows the circular polarization of light isolation which divides the natural light into the circular polarization of light on either side through reflection and transparency according to GURANJAN orientation, the proper cholesteric-liquid-crystal layer which shows this circular polarization of light isolation in this invention can be used for it. Therefore, although the cholesteric-liquid-crystal layer may consist of a cell object of low-molecular-weight cholesteric liquid crystal etc., what consists of cholesteric-liquid-crystal polymer is more desirable than points, such as handling nature and thin film nature.
[0013] In the aforementioned case, the cholesteric-liquid-crystal layer which consists of cholesteric-liquid-crystal polymer used for formation of a polarizing element can be obtained as double **** which supported monolayer objects, such as for example, a cholesteric-liquid-crystal polymer film, and it with plastic film etc. Cholesteric-liquid-crystal polymer carries out GURANJAN orientation of the cholesteric-liquid-crystal layer more desirable than points, such as angle-of-visibility expansion of a liquid crystal display etc., in the state with few defects of a domain etc.
[0014] A proper thing may be used for the aforementioned cholesteric-liquid-crystal polymer, and there is especially no limitation in it. Therefore, various things, such as a principal chain type with which the straight-line-like atomic group (meso gene) of the conjugate property which gives a liquid crystal stacking tendency was introduced into the principal chain and side chain of polymer, and a side-chain type, can be used. The larger cholesteric-liquid-crystal polymer of a double refractive-index difference

becomes large, and its wavelength region of circular dichroism (selective reflection) is more desirable than points, such as a margin over mitigation of a superposition number of layers, or the wavelength shift at the time of a large angle of visibility. In addition, as a liquid crystal polymer, that whose glass transition temperature is 30-150 degrees C is more desirable than points, such as handling nature and the stability of the orientation in practical use temperature.

[0015] Incidentally, as said example of a principal chain type liquid crystal polymer, it has the structure which combined the meso gene machine which minds the spacer section which gives flexibility if needed, and consists of a Para substitution ring compound etc., for example, polymer, such as a polyester system, a polyamide system, a polycarbonate system, and a polyester-imide system, is raised.

[0016] Moreover, a thing, a nematic system liquid crystal polymer of low-molecular chiral agent content, a liquid crystal polymer of chiral component introduction, a mixed liquid crystal polymer of a nematic system and a cholesteric system, etc. which have the low-molecular-liquid-crystal compound (meso gene section) which makes a polyacrylate, a polymethacrylate, a polysiloxane, poly malonate, etc. a principal chain skeleton, minds the spacer section which consists of an atomic group of conjugate property as a side chain as an example of a side-chain type liquid crystal polymer if needed, and consists of a Para substitution ring compound etc. are raised.

[0017] Like the above, it can consider as the thing of a cholesteric stacking tendency with the method which introduces the proper chiral component which consists of a compound which has an asymmetrical carbon also in what has the Para substitution ring compound which gives the nematic stacking tendency which consists of the Para substitution aromatic unit, the Para substitution cyclohexyl ring unit, etc. like for example, an azomethine form, an azo form, an AZOKISHI form and an ester form, a biphenyl form and a phenylcyclohexane form, and bicyclo hexane type, a low-molecular chiral agent, In addition, a cyano group, the alkyl group, alkoxy group of the end substituent in the para position in the Para substitution ring compound, etc. may be proper.

[0018] Moreover, as the spacer section, for example, polymethylene chain-(CH2) n-, polyoxymethylene chain-(CH2CH2O) m-, etc. which show flexibility are raised. the chemical structure of the meso gene section etc. determines suitably the number of recurrence of the structural unit which forms the spacer section -- having -- general -- the case of a polymethylene chain -- n -- 0-20, and the case where they are 2-12, and a polyoxymethylene chain above all -- m -- 0-10 -- it is 1-3 above all

[0019] Formation of the cholesteric-liquid-crystal layer which consists of cholesteric-liquid-crystal polymer can be performed by the method according to orientation processing of conventional low-molecular liquid crystal. Incidentally as the example, on a transparent base material, a polyimide and polyvinyl alcohol, The orientation film which formed films, such as polyester, a polyarylate and a polyamidoimide, and polyether imide, and carried out rubbing processing with the rayon cloth etc., A liquid crystal polymer is developed on the proper orientation film which consists of a method vacuum evaporationo layer of slanting of SiO2, or an orientation film by extension processing. Or more than a glass transition temperature It heats under to isotropic phase transition temperature, after the liquid crystal polymer molecule has carried out GURANJAN orientation, it cools under to a glass transition temperature, and it considers as a vitreous state, and the method of forming the solidification layer by which the orientation concerned was fixed etc. is raised.

[0020] As the aforementioned transparent base material, proper things, such as a monolayer film which consists of plastics like a triacetyl cellulose, polyvinyl alcohol and a polyimide, a polyarylate and polyester, a polycarbonate, a polysulfone and polyether sulphone, an amorphous polyolefine and denaturation acrylic polymer. and an epoxy system resin, for example, a laminated film, an oriented film, or a glass plate, can be used. Plastic film is more desirable than points, such as thin-shape-izing.

[0021] Expansion of a liquid crystal polymer can carry out thin layer expansion of the solution by the solvent of a liquid crystal polymer by proper methods, such as the spin coat method, the roll coat method, the flow coat method and the printing method, a dip coating method and the flow casting forming-membranes method, the bar coat method, and gravure, and can perform it by the method of carrying out dryness processing if needed etc. As the aforementioned solvent, proper things, such as a methylene chloride, a cyclohexanone and a trichloroethylene, a tetrachloroethane and N-methyl

pyrrolidone, and a tetrahydrofuran, can be used, for example.
[0022] Moreover, the heating melt of a liquid crystal polymer and the heating melt in the state of presenting an isotropic phase preferably can be developed according to the above, and the method which does not use solvents, such as a method which develops to a thin layer and it is made to solidify further, maintaining the melting temperature if needed, therefore the health nature of a work environment, etc. can develop a liquid crystal polymer also by the good method.
[0023] Heat-treatment for carrying out orientation of the expansion layer of a liquid crystal polymer can be performed by heating to the temperature requirement from the glass transition temperature of a liquid crystal polymer to isotropic phase transition temperature, i.e., the temperature requirement which a liquid crystal polymer presents a liquid crystal phase, as described above. Moreover, fixation of an orientation state can be performed by cooling under to a glass transition temperature, and there is especially no limitation about the cooling condition. Usually, since the aforementioned heat-treatment can be performed at the temperature of 300 degrees C or less, generally a natural-air-cooling method is taken. In addition, various additives, such as a stabilizer and plasticizer metallurgy groups, can be blended with the developing solution of cholesteric-liquid-crystal polymer if needed.
[0024] Although solidification layer thickness of the liquid crystal polymer formed on a transparent base material in the above is set to 5 micrometers or less as described above from points, such as orientation disorder and prevention of a permeability fall, the liquid crystal polymer solidification layer formed on the transparent base material is used also as an one object with a transparent base material, exfoliates from Japanese lacquer and a transparent base material, and can also be used as a film etc. Therefore, the polarizing element which comes to superimpose a cholesteric-liquid-crystal layer may have the transparent base material 11 on the middle of the superposition layer, or the outside, as illustrated to drawing 1 .
[0025] Moreover, a part or all of this transparent base material can also be replaced by the transparent glue line for carrying out the laminating of the polarizing element to other members since a cholesteric-liquid-crystal layer is superimposed. Therefore, a polarizing element may have a transparent glue line with a transparent base material if needed on the middle of the superposition layer, or the outside. Proper adhesives, such as a binder, can be used for formation of a transparent glue line. In addition, when using a cholesteric-liquid-crystal layer as an one object with a transparent base material, it is more desirable [especially the overall thickness / 5-300 micrometers] in the above, than points, such as thin-shape-izing, that it is 10-200 micrometers above all 500 micrometers or less.
[0026] Although the combination of the cholesteric-liquid-crystal layer to superimpose is arbitrary, it is more desirable than points, such as expansion (wide-band-izing) of the wavelength range of circular dichroism, to consider as the combination of the cholesteric-liquid-crystal layer from which the main wavelength of circular dichroism differs. That is, the circular polarization of light isolation from which a wavelength property differs based on a difference of the spiral pitch of clan JAN orientation can be shown, those circular dichroism can compound by superimposing the cholesteric-liquid-crystal layer from which the main wavelength of circular dichroism differs, and cholesteric liquid crystal can expand the wavelength region of isolation.
[0027] the combination from which a spiral pitch differs several sorts of the cholesteric-liquid-crystal layer which is incidentally in the range whose main wavelength of circular dichroism is 300-900nm -- and the polarizing element which can cover a light region can be efficiently formed by superimposing in the combination which reflects the circular polarization of light of the same direction In addition, the point superimposed in the combination of what reflect the circular polarization of light of the same direction aims at increase in quantity of the polarization in the state where the polarization state and bird clapper which arrange the phase state of the circular polarization of light reflected on each class, and are different in each wavelength region can be prevented and used.
[0028] It is effective also in improvement in the degree of polarization according to increase of thickness in addition to said wide-band-izing of circular dichroism, and superposition of a cholesteric-liquid-crystal layer is so advantageous that it enlarges cholesteric-liquid-crystal layer thickness by superposition in respect of degree of polarization. Therefore, the number of superposition of a

cholesteric-liquid-crystal layer can be made into the proper number more than two-layer according to wide-band-izing, degree of polarization, etc. of circular dichroism which are made into the purpose, and, especially generally let it above all be the number of superposition of 3-10 layers 2-15 layers 20 or less layers.

[0029] Proper methods, such as a method and adhesion mode of processing which minded the transparent glue line as described above, can perform superposition of a cholesteric-liquid-crystal layer every mere pile, for example. In this case, if the superposition sequence of a cholesteric-liquid-crystal layer is attracted, its sequence that it is based on the main wavelength of the circular dichroism of a cholesteric-liquid-crystal layer in the superposition direction, i.e., the thickness direction, and the spiral pitch of GURANJAN orientation increases or decreases from points, such as a viewing-angle property at the time of applying to a liquid crystal display etc., is more desirable than points, such as suppression of the color change by viewing-angle change.

[0030] In the above, when there was an inversion layer of a spiral pitch based on the main wavelength of circular dichroism in the superposition direction (i.e., if change of a spiral pitch became the maximum point or the thing which shows a dot very much), and the transmitted light carries out color change greatly by viewing-angle change and applies to a liquid crystal display etc., a viewing-angle property may fall remarkably.

[0031] A spiral pitch may not change in the thickness direction and the cholesteric-liquid-crystal layer which forms a polarizing element may change. The cholesteric-liquid-crystal layer from which a spiral pitch changes in the thickness direction has the advantage which shows the wavelength region of large circular dichroism to the spiral pitch based on having width of face as described above.

[0032] Although the main wavelength of circular dichroism differs the predetermined number of two sheets or three sheets or more of cholesteric-liquid-crystal polymer layers which carried out orientation processing, for example, operation of pasting up by thermocompression bonding in combination etc. can perform manufacture of the cholesteric-liquid-crystal layer from which a spiral pitch changes in the thickness direction. Thermocompression bonding can perform a cholesteric-liquid-crystal polymer layer more than a glass transition temperature through proper heating press meanses, such as a roll laminator, by the method with the proper method which heats and carries out sticking-by-pressure processing under at isotropic phase transition temperature.

[0033] In the case of the solidification layer of a liquid crystal polymer which consists of an one object with the above-mentioned transparent base material, the polarizing element by the cholesteric-liquid-crystal layer from which a spiral pitch changes in the thickness direction, as a result this invention can be obtained by carrying out superposition processing according to the above so that the solidification layers may be close.

[0034] In addition, the cholesteric-liquid-crystal layer from which a spiral pitch changes in the thickness direction may show the wavelength region of the continuous circular dichroism, and may show the wavelength region of discontinuous circular dichroism. A cholesteric-liquid-crystal layer more desirable than points, such as color nonuniformity prevention, shows the wavelength region of the continuous circular dichroism.

[0035] Manufacture of the cholesteric-liquid-crystal layer which shows the wavelength region of the continuous circular dichroism can heat the superposition object of a cholesteric-liquid-crystal polymer layer from which a spiral pitch changes in the thickness direction formed by the thermocompression bonding operation described above, for example under to isotropic phase transition temperature more than a glass transition temperature, and can be performed by the method of forming the layer which the cholesteric-liquid-crystal polymer which forms an up-and-down layer in the adhesion interface mixed etc.

[0036] Also unlike the layer of the upper and lower sides of a spiral pitch, the cholesteric-liquid-crystal polymer layer in which the cholesteric-liquid-crystal polymer of an up-and-down layer was mixed, and was formed in the above forms the cholesteric-liquid-crystal layer from which the spiral pitch changed to the multi-stage story in the thickness direction, and the spiral pitch takes the mean value of the cholesteric-liquid-crystal polymer layer which forms an up-and-down layer, and forms usually the field

which shows the wavelength region of the circular dichroism which continued with the up-and-down layer.
[0037] Therefore, when it uses in the combination of the cholesteric-liquid-crystal polymer layer which the wavelength region of circular dichroism does not overlap in an up-and-down layer, i.e., the combination in which the lack region discontinuously called at the wavelength region of circular dichroism exists, the cholesteric-liquid-crystal polymer layer formed of mixture of an up-and-down layer can fill the aforementioned lack region, and can continuation-ize the wavelength region of circular dichroism.
[0038] Therefore, for example, the wavelength region of circular dichroism means that the cholesteric-liquid-crystal layer which shows circular dichroism using two sorts of cholesteric-liquid-crystal polymer layers, a thing 500nm [or less] and a thing 600nm or more, also about the light of the 500-600nm wavelength region which is a discontinuous region of the aforementioned wavelength region can be obtained, and this can form the cholesteric-liquid-crystal layer which is superposition of a few cholesteric-liquid-crystal polymer layer, and shows the wavelength region of latus circular dichroism.
[0039] As for especially the cholesteric-liquid-crystal layer that is used for formation of a polarizing element and from which a spiral pitch changes in the thickness direction, it is more desirable than points, such as fall prevention of circular dichroism, that 100nm or less of 85nm or less of the spiral pitch difference is 80nm or less above all. In addition, it is desirable to satisfy the superposition sequence structure where a spiral pitch increases or decreases in the thickness direction which was described above also in the case of the polarizing element which comes to use the cholesteric-liquid-crystal layer from which a spiral pitch changes in the thickness direction partially or as a whole.
[0040] The polarizing element by this invention can be preferably used for formation of a liquid crystal display etc. In this case, a polarizing element can also be used as an optical element which comes to carry out a laminating to more than two-layer [of the proper optical layer which consists of 1/4 wavelength plate, a viewing-angle compensating plate or a polarizing plate, etc. / one layer or two-layer]. An optical layer can be arranged in the proper position of one side of a polarizing element, or both sides.
[0041] The example of an optical element was shown in drawing 2 and drawing 3 . 2 is 1/4 wavelength plate, and, as for 21 and 22, a phase contrast layer and 3 are polarizing plates. Like the example of drawing, 1/4 wavelength plate 2 may consist of a superposition object of the phase contrast layers 21 and 22 more than one layer or two-layer, and the optical layer used for formation of an optical element may have a proper layer gestalt like a monolayer object or double ****.
[0042] 1/4 wavelength plate is for linearly-polarized-light-izing the circular polarization of light reflected by the polarizing element, or it prepared in drawing 2 and drawing 3 like instantiation at one side or both sides of a polarizing element 1 and penetrated the polarizing element, and it is formed in the phase contrast layer more than one layer or two-layer.
[0043] In the case of a light region, as 1/4 wavelength plate (phase contrast layer), that whose transverse-plane phase contrast is 100-180nm can use preferably from points, such as a linearly polarized light-ized effect and compensation of the color change by the slanting transmitted light. That is, when the refractive index of ny and the thickness direction is set to nz and thickness is set to d for the refractive index of the direction which intersects perpendicularly the maximum refractive index within a field with nx and it, 1/4 wavelength plate which satisfies formula:(nx-ny) d=**nd=100-180nm can use preferably.
[0044] The phase contrast layer used if needed with the phase contrast layer which shows aforementioned 1 / 4 wavelength-plate functions It is made in agreement with the color balance of the light which carried out the perpendicular transparency of the color balance of the light which carried out the slanting transparency of the phase contrast layer which shows 1 / 4 wavelength-plate functions as much as possible. It is [aiming at making the check by looking through the polarizing plate into neutral colors with more little coloring etc.] for compensation, and transverse-plane phase contrast (**nd) is desirable no less than 100-720nm's, and it is used.
[0045] Nz expressed with formula:(nx-nz)/(nx-ny) when, as for 1/4 wavelength plate which can be used

in the above more preferably than points, such as reduction of the angular dependence of the color change by viewing-angle change, or a phase contrast layer, the spiral pitch in a polarizing element arranges 1/4 wavelength plate to a large cholesteric-liquid-crystal polymer layer side -- 1.1--1 -- it is the thing of -0.2--0.8 above all the case where the spiral pitch in a polarizing element arranges to a small cholesteric-liquid-crystal polymer layer side on the other hand -- Nz -0.5--2.5 -- 1/4 wavelength plate or phase contrast layer of -0.8--2.0 is desirable above all

[0046] As for the above-mentioned phase contrast layer, what may form with the arbitrary quality of the materials, is excellent in transparency, shows 80% or more of light transmittance above all, and gives uniform phase contrast is desirable. the oriented film which generally consists of plastics, such as a polycarbonate, polyester, a polysulfone and polyether sulphone, polystyrene and polyethylene, a polyolefine like polypropylene, polyvinyl alcohol and cellulose acetate system polymer, a polyvinyl chloride and a polyvinylidene chloride, a polyarylate and a polymethylmethacrylate, and a polyamide, and a liquid crystal polymer -- the liquid crystal polymer of twist orientation etc. is used above all

[0047] The phase contrast layer with the large refractive index of the above-mentioned thickness direction can be formed by the method with the proper method which carries out heating extension of the film which formed the aforementioned polymer etc. by proper methods, such as the casting method and an extrusion method, by methods, such as one shaft and two shafts, under adhesion for example, with a thermal-contraction nature film. Properties in a phase contrast layer, such as the above-mentioned **nd and Nz, are controllable by changing conditions, such as the quality of the material of a film, thickness and draw magnification, and extension temperature. Based on a monolayer object, 10-500 micrometers, although the general thickness of a phase contrast layer is 20-200 micrometers above all, it is not limited to this.

[0048] In addition, when forming phase contrast layers, such as 1/4 wavelength plate, by the liquid crystal polymer, it can obtain as what has a gestalt with the proper orientation layer of the liquid crystal polymer supported by the oriented film and transparent base material of a liquid crystal polymer according to the case of the above-mentioned cholesteric-liquid-crystal layer etc. When a liquid crystal polymer is used, the target phase contrast layer can also be formed without extension processing.

[0049] Like the above, 1/4 wavelength plate may consist of a phase contrast layer of a monolayer, and may consist of a superposition object of the two-layer or the three or more-layer phase contrast layer from which phase contrast is different. Superposition-izing of the phase contrast layer from which phase contrast is different is effective in expansion of the wavelength range which functions as 1/4 target wavelength plate and a target compensating plate. When considering as the superposition object of a phase contrast layer, it is more desirable than the point which it described above that the refractive index of the thickness direction arranges a phase contrast layer higher than at least one side of the refractive index within a field one layer or more than two-layer.

[0050] An optical element more desirable than points, such as the improvement effect of brightness, penetrates the linearly polarized light of a predetermined polarization shaft, and reflects the other light. An optical element can also be made into the gestalt which has arranged the polarizing plate 3 above 1/4 wavelength plate 2 like instantiation to drawing 3 . In this case, it can apply to a liquid crystal cell as it is, without using a separate polarizing plate.

[0051] As a polarizing plate, what has the proper thing which prepared transparent protection layer can be used for the absorbed type polarizing plate and polyene oriented film which made the dichroism matter contain, or the film concerned. Incidentally as an example of an absorbed type polarizing plate, the film which dichroism matter, such as iodine and a dichromatic dye, was made to stick to the hydrophilic high polymer film like a polyvinyl alcohol system film, a partial formal-ized polyvinyl alcohol system film, and an ethylene-vinylacetate-copolymer system partial saponification film, and was extended is raised. Moreover, as an example of a polyene oriented film, the dehydration processing object of polyvinyl alcohol, the desalting acid-treatment object of a polyvinyl chloride, etc. are raised. In addition, although the thickness of a polarizing plate is 5-80 micrometers usually, it is not limited to this.

[0052] It is made to penetrate a polarizing plate, preventing an absorption loss for the light highly

linearly-polarized-light-ized through the bright achievement nature of a display, i.e., 1/4 wavelength plate, in formation of a liquid crystal display as much as possible, and the high thing of degree of polarization is preferably used for it like the absorbed type polarizing plate of dichroism matter content etc. from the point of obtaining the display of the good contrast ratio by the incidence of the advanced linearly polarized light to a liquid crystal cell etc. Above all, the absorbed type polarizing plate of 99% or more of dichroism matter content is especially used [a light transmittance] for degree of polarization preferably 95.0% or more at 40% or more.

[0053] Especially, the aforementioned transparent protection layer is prepared for the purpose of protection, when lacking in water resistance like the polarizing plate of dichroism matter content, and although it considered as the application method and film of plastics, it can be formed by the method with a proper laminating method etc. When forming by separation objects, such as a film, it is more desirable than points, such as prevention of a reflective loss, to carry out laminating unification by the glue line. The thickness of transparent protection layer may be determined suitably and, especially generally is set to 1-300 micrometers 500 micrometers or less above all 1mm or less. In addition, what has the proper thing illustrated as plastics in an above-mentioned transparent base material, an above-mentioned phase contrast layer, etc. can be used.

[0054] In addition, a transparent resin layer can also be formed in the gestalt of surface detailed irregularity structure by the method which makes a particle contain. What shows transparency also for conductive things, such as the silica whose mean particle diameter is 0.5-5 micrometers, an alumina, a titania, a zirconia, a tin oxide, indium oxide, a cadmium oxide, and an antimony oxide, in transparent resin layers, such as organic system particles, such as a certain inorganic system particle, and bridge formation or a non-crosslinked polymer, is used for the particle. The content of a particle has 5 - 20 common % of the weight above all two to 25% of the weight.

[0055] It faces arranging a polarizing plate to the 1/4 wavelength-plate up side, and although the arrangement angle of the polarizing plate to 1/4 wavelength plate can be suitably determined as the phase contrast property of 1/4 wavelength plate, or it according to the property of the circular polarization of light which carries out incidence etc., it is more desirable than points, such as improvement in efficiency for light utilization, to arrange the transparency shaft of a polarizing plate in parallel as much as possible to the polarization direction (the oscillating direction) of the light linearly-polarized-light-ized through 1/4 wavelength plate.

[0056] The polarizing element and optical element by this invention can be preferably used for formation of various equipments, such as a lighting system and a liquid crystal display, for example, a lighting system and a liquid crystal display can be formed by combining a polarizing element or an optical element, the surface light source, or a liquid crystal cell. The optical element which consists of the polarizing element and 1/4 wavelength plate which were incidentally described above, and has a polarizing plate to the 1/4 wavelength-plate up side if needed divides the light from the light sources, such as the natural light, into the circular polarization of light on either side as the reflected light and the transmitted light through a polarizing element, linearly-polarized-light-izes the circular polarization of light and elliptically polarized light which penetrated the polarizing element by 1/4 wavelength plate, and enables it to supply them to a polarizing plate etc.

[0057] Therefore, as illustrated to drawing 4 and drawing 5 , this polarizing element and optical element can be arranged above the proper surface light sources 4, such as a side light type light guide plate and an EL lamp, and a lighting system suitable as a back light of a liquid crystal display etc. can be formed. In addition, the surface light source of the example of drawing comes to arrange the light source 42 on the side of a light guide plate 4.

[0058] According to the lighting system of the aforementioned example of a view, the light from the light source 42 carries out incidence to the side of a light guide plate 4, outgoing radiation is carried out from the front face of a light guide plate through the reflection in a rear face etc., and the outgoing radiation light penetrates the polarizing element 1 arranged to the front-face side of a light guide plate as the predetermined circular polarization of light and predetermined elliptically polarized light, is linearly-polarized-light-ized through 1/4 wavelength plate 2, and carries out incidence to a polarizing plate 3. On

the other hand, it is reflected through the reflecting layer 41 which carried out re-incidence to the light guide plate, and has been arranged at the rear face etc., and incidence of the light reflected by the polarizing element 1 as the circular polarization of light besides predetermined is again carried out to a polarizing element 1 as a return light.
[0059] In case it is reflected with the rear face of a light guide plate, a polarization state is changed to the reflected light by the aforementioned polarizing element, and it turns into the predetermined circular polarization of light to which a part or all the reflected lights may penetrate a polarizing element. Therefore, the reflected light by the polarizing element is shut up between a polarizing element and a light guide plate until it turns into the predetermined circular polarization of light which may penetrate the polarizing element, and it repeats reflection among them.
[0060] While the reflected light is shut up between a polarizing element and the reflecting layer of a light guide plate in a side light type light guide plate like the above and reflection will be repeated by the meantime, it will be in the state where a polarization state is changed and a polarizing element may be penetrated, and outgoing radiation is carried out with the initial transmitted light of an incident light, and, thereby, the unused part of the light by the reflective loss is reduced.
[0061] On the other hand, the light which carried out outgoing radiation from the polarizing element is changed into the linearly polarized light or elliptically polarized light with many linearly polarized light components through 1/4 wavelength plate, a polarizing plate is penetrated without hardly absorbing this conversion light, when the direction of the linearly polarized light agrees with the transparency shaft of a polarizing plate, and, thereby, the unused part of the light by the absorption loss is also reduced. Consequently, in the former, the light used as the reflective loss or the absorption loss can also be used effectively, and the use efficiency of light can be raised. Therefore, as the surface light source, a side light type light guide plate can use preferably.
[0062] The proper thing which has a reflecting layer at the rear face and was made to carry out outgoing radiation of the light to a front-face side as the aforementioned light guide plate can be used. Preferably, what has absorption [be nothing] of light that carries out outgoing radiation efficiently is used. (The cold, heat) lines, such as a cathode-ray tube, -- a well-known side light type back light etc. is the example in the liquid crystal display which arranges the light sources, such as the light source and light emitting diode, on the side of a light guide plate 4, and was made to carry out outgoing radiation of the light transmitted to the light guide plate in the inside of a light guide plate to the one side side of a board by diffusion, reflection and diffraction, interference, etc.
[0063] In the above, the light guide plate which was made to carry out outgoing radiation of the internal transmission light to an one side side can be obtained above all as concavo-convex structure, a thing which gave concavo-convex detailed prism array-like structure at what prepared the diffuser in transparence, the optical outgoing radiation side of a translucent resin board, or its rear face the shape of a dot, and in the shape of a stripe, and the rear face of a resin board.
[0064] Although the light guide plate which carries out outgoing radiation of the light to one field side may have the function which carries out polarization conversion of the light reflected by the polarizing element by itself, it can prevent a reflective loss nearly completely by forming a reflecting layer 41 in the rear face of a light guide plate. Reflecting layers, such as a diffuse reflection layer and a specular reflection layer, are excellent in the function which carries out polarization conversion of the light reflected by the polarizing element, and can be preferably used in this invention.
[0065] Based on the diffusion, a polarization state is intermingled at random and the diffuse reflection layer incidentally represented with a concavo-convex field etc. cancels a polarization state. **
[reflection of the circular polarization of light / reverse / the polarization state / moreover, / the specular reflection layer represented with the metal side which consists of vacuum evaporationo layers, such as aluminum and silver, a resin board which prepared it, a metallic foil, etc.]
[0066] The diffusion board for obtaining the prism array layer 5 which consists of a prism sheet for controlling the direction of outgoing radiation of light like instantiation to drawing 5 etc., and uniform luminescence on the occasion of formation of a lighting system, the reflective means for returning leakage light, and a line -- one layer or more than two-layer are arranged if needed in predetermined

positions, such as a vertical side of a light guide plate 4, and the side, and auxiliary means, such as a light source electrode holder for leading the outgoing radiation light from the light source to the side of a light guide plate, are used as a proper combination object

[0067] In the above, the dot given to the prism array layer arranged to the front-face side (optical outgoing radiation side) of a light guide plate, the diffusion board, or the light guide plate may function as a polarization conversion means to change the phase of the reflected light by the diffusion effect etc. In addition, when arranging the prism array layer more than two-layer, arranging in the state where an optical anisotropy is canceled is desirable by making the prism array in each class intersect perpendicularly or cross, and being able to shift the arrangement angle of an array.

[0068] In this invention, the laminating unification of each part articles which form an optical element and a lighting system, such as a polarizing element, 1/4 wavelength plate and a polarizing plate, and a light guide plate, can be carried out through a glue line if needed. Laminating unification of formation parts is effective in the fall prevention of compensation efficiency, a polarization conversion efficiency, etc. by fall prevention of display grace etc., and gap of optical system by invasion prevention of suppression of the reflective loss in respect of each field, the foreign matter to a field side, etc. Therefore, when a polarizing element, 1/4 wavelength plate and a polarizing plate, a light guide plate, etc. are formed in two or more layers, respectively, it is desirable to carry out the adhesion unification of each class through a glue line etc.

[0069] The adhesive layer which is excellent in stress relaxation nature above all although proper adhesives etc. can be used for the aforementioned laminating unification suppresses the stress produced in a polarizing element, 1/4 wavelength plate, a polarizing plate, etc. with the heat from the light source etc., change of the refractive index generated by photoelasticity deformation is prevented, and it can use more preferably than the point which forms the liquid crystal display which is bright and is excellent in visibility or the reliability of display grace.

[0070] The transparent binder which comes to use proper polymer, such as for example, an acrylic polymer, silicone system polymer, polyester and polyurethane, a polyether, and synthetic rubber, can be used for formation of an adhesive layer. Above all, an acrylic binder can use preferably from points, such as optical transparency, and an adhesion property, weatherability. moreover, points, such as the tightness of the photoelasticity deformation by relief of the internal stress generated inside a layered product with heat as an adhesive layer, -- a relaxation modulus -- 2x105 - 1x107 dyne/cm2 -- the thing of 2x106 - 8x106 dyne/cm2 is desirable above all

[0071] You may determine the thickness of an adhesive layer suitably. Especially generally 2-200-micrometer 1-500 micrometers are set to 5-100 micrometers above all from points, such as adhesive strength and thin-shape-izing. In addition, proper additives, such as the tackifier like a petroleum system resin, a rosin system resin, a terpene system resin and a cumarone indene system resin, a phenol system resin and a xylene system resin, and an alkyd system resin, a phthalic ester and phosphoric ester, chloroparaffin, a polybutene and the softener like a polyisobutylene or other various bulking agents, and an antioxidant, can be blended with an adhesive layer if needed.

[0072] ** arrival of the adhesive layer which prepared thin nerves, such as a film, on the separator which comes to carry out surface treatment by the remover as formation methods, such as an optical element which carried out laminating unification, for example is carried out to the adhesion side of a polarizing element, 1/4 wavelength plate is stuck by pressure on it, ** arrival of the adhesive layer is further carried out similarly on its 1 / 4 wavelength plate, and the method which arranges and sticks a polarizing plate by pressure on it is held.

[0073] Moreover, after carrying out ** arrival of the adhesive layer prepared in adhesion sides, such as a light guide plate, on separator and arranging and sticking a polarizing element by pressure on it, The method which carries out ** arrival of the adhesive layer similarly on it, and sticks 1/4 wavelength plate and a polarizing plate as occasion demands by pressure one by one, Or the laminating of the adherends, such as a polarizing element, 1/4 wavelength plate and a polarizing plate, and a light guide plate, is carried out in predetermined sequence through the adhesive layer beforehand prepared in the predetermined adhesion side, and the method which carries out press processing and sticks it by pressure

in package is held.
[0074] To the polarizing element by this invention, an optical element, and a lighting system, proper optical layers, such as an optical diffusion board, can also be arranged in the proper position between the front face and layer. In this case, an optical layer may carry out laminating unification through the adhesive layer which is excellent in stress relaxation nature at a polarizing element etc. This prior adhesion method has an advantage -- the element which is excellent in the reliability by which quality was stabilized rather than the sequential adhesion method in an assembly line is obtained.
[0075] In addition, in this invention, ultraviolet-absorption ability can also be given with the method which processes parts which form a polarizing element, an optical element, and a lighting system, such as a cholesteric-liquid-crystal layer, 1/4 wavelength plate and a polarizing plate, a light guide plate, a glue line, and other optical layers, with ultraviolet ray absorbents, such as for example, a salicylate system compound, a benzo phenol system compound, a benzotriazol system compound, a cyanoacrylate system compound, and a nickel complex salt system compound.
[0076] A polarizing element and an optical element according to this invention as mentioned above prevent a reflective loss by carrying out polarization conversion of the reflective circular polarization of light by the polarizing element, and reusing as an outgoing radiation light, prevent the absorption loss by the polarizing plate by changing into the state where carry out phase control of the outgoing radiation light through 1/4 wavelength plate, and the linearly polarized light component of polarizing plate permeability is included richly, and can make it possible to aim at improvement in brightness combining the proper surface light sources, such as a side light type light guide plate.
[0077] Therefore, the light which is excellent in the use efficiency of light and is easy to penetrate a polarizing plate is offered, and it can use for various equipments preferably as a back light system in a liquid crystal display etc. from large-area-izing etc. being easy. In this case, it is more desirable than the point of using the light which carried out outgoing radiation of the 1/4 wavelength plate as the light source that the linearly polarized light component which may penetrate a polarizing plate as a major-axis direction component of the linearly polarized light or elliptically polarized light etc. is included 70% or more above all 65% or more.
[0078] The liquid crystal display which used the lighting system by this invention for the back light system was illustrated to drawing 6 and drawing 7 . This arranges a liquid crystal cell 6 through a polarizing element or an optical element to the optical outgoing radiation side side of the light guide plate 4 which forms a lighting system, and a liquid crystal cell 6 is arranged like the example of drawing at the 1/4 wavelength-plate 2, i.e., optical outgoing radiation of lighting system, side of an optical element. In addition, 61 are a polarizing plate and an optical diffusion board for check-by-looking light diffusion in 7 among drawing.
[0079] The optical element and lighting system by this invention can be especially used for the formation of a liquid crystal display which has a polarizing plate on both sides of a liquid crystal cell preferably. In addition, in the case of the optical element which has a polarizing plate to the 1/4 wavelength-plate up side, the polarizing plate of the side which prepares the optical element in a liquid crystal cell is omissible.
[0080] A liquid crystal display is formed by assembling suitably component parts, such as a polarizing plate, a liquid crystal cell, a back light, and a viewing-angle compensating plate as occasion demands, and generally, incorporating a drive circuit etc. Although there is especially no limitation except for the point which arranges an optical element or a lighting system like the above through a polarizing-element, or 1 / 4 wavelength-plates side or a polarizing plate side in this invention to the check-by-looking tooth-back side of a liquid crystal cell and it can form according to the former, as for each component part, it is desirable that adhesion unification is carried out through an adhesive layer.
[0081] Moreover, although the polarizing element and optical element by this invention, and a lighting system can be preferably used for the thing using the liquid crystal cell with the need of carrying out incidence of the light of a polarization state, for example, a twist nematic liquid crystal, and the super twist nematic liquid crystal etc., they can use the liquid crystal and the dichroism matter of a non-twisting system for the thing using the liquid crystal of the guest host system distributed in liquid

crystal, or the ferroelectric liquid crystal etc.
[0082] On the occasion of formation of a liquid crystal display, an optical layer with the proper viewing-angle compensating plate prepared between the optical diffusion board formed, for example on the polarizing plate by the side of a check by looking, an anti glare layer, an antireflection film and a protective layer, a guard plate or a liquid crystal cell, and polarizing plates, such as a check-by-looking side, can be arranged suitably. Incidentally the optical layer (JP,4-268505,A, the PCT public presentation 95/No. 17691 official report) which carried out the laminating of the thin film of two or more polymer arranged between liquid crystal cells to the back light can be usually arranged for the purpose of improvement in brightness etc.
[0083] The aforementioned viewing-angle compensating plate can be used also as an optical element which carried out the laminating to the polarizing element etc. as described above in this invention for the purpose of compensating the wavelength dependency of a birefringence etc. and raising visibility etc. A viewing-angle compensating plate is arranged if needed between the polarizing plate by the side of a check by looking or/and a back light, and a liquid crystal cell etc.
[0084] In addition, as a viewing-angle compensating plate, a proper thing can be used according to a wavelength region etc., and it may be formed as a superposition layer of the phase contrast layer more than one layer or two-layer. A viewing-angle compensating plate can be obtained as an oriented film, a liquid crystal polymer layer, etc. of instantiation by the 1/4 above-mentioned wavelength plate.
[0085]
[Example] The 20-% of the weight tetrahydrofuran solution of example 1 acrylic thermotropic cholesteric-liquid-crystal polymer After carrying out coating to the polyvinyl alcohol rubbing processing side (about 0.1-micrometer **) of a cellulose-triacetate film with a thickness of 50 micrometers with a wire bar and carrying out heating orientation processing for 5 minutes at 150**2 degrees C, it cools radiationally at a room temperature. By the method which forms a cholesteric-liquid-crystal layer with a thickness of 2 micrometers, the wavelength region of circular dichroism penetrated the left-handed circularly-polarized light by 400-500nm, 450-550nm, 500-600nm, or 600-700nm, and Hayes obtained 2% of cholesteric-liquid-crystal layers [four sorts of].
[0086] Subsequently, the liquid crystal side was stuck, heating orientation processing of the cholesteric-liquid-crystal layer and the 450-550nm cholesteric-liquid-crystal layer whose wavelength region of the aforementioned circular dichroism is 400-500nm was carried out for 2 minutes at 150**2 degrees C, and the spiral pitch difference of the thickness direction obtained the cholesteric-liquid-crystal layer which shows circular dichroism by 35nm in a 400-550nm wavelength region (superposition). Moreover, according to the above, the spiral pitch difference of the thickness direction obtained the cholesteric-liquid-crystal layer which shows circular dichroism by 65nm in a 500-700nm wavelength region (superposition) using the cholesteric-liquid-crystal layer and the 600-700nm cholesteric-liquid-crystal layer whose wavelength region of circular dichroism is 500-600nm.
[0087] Next, the spiral pitch of the cholesteric-liquid-crystal layer which shows circular dichroism (superposition) superimposed the side with a small spiral pitch for the cholesteric-liquid-crystal layer which shows circular dichroism (superposition) on the large side through the transparent acrylic adhesive layer with a thickness of 20 micrometers in the 400-550nm wavelength region obtained above as an adhesion side in the 500-700nm wavelength region, and the polarizing element was obtained.
[0088] The transverse-plane phase contrast of 140nm which consists of an oriented film of a polycarbonate, and 1/4 wavelength plate of Nz-0.35 were pasted up on the large spiral pitch side of the polarizing element obtained above through the acrylic adhesive layer with a thickness of 20 micrometers, the optical element was obtained, to the polarizing-element side, the surface light source has been arranged and the lighting system was obtained. In addition, the surface light source has arranged the cold cathode tube with a diameter of 3mm on the side of an acrylic light guide plate with a thickness of 4mm in which dot printing was given to the rear face, consisted of what prepared the reflective sheet which surrounds with a vacuum-plating-of-aluminium film, and becomes the aforementioned dot inferior surface of tongue from foaming polyester film, has arranged it under a polarizing element through an acrylic adhesive layer with a thickness of 20 micrometers, carried out

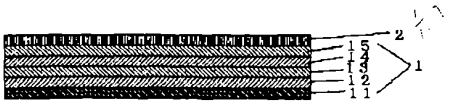
press sticking by pressure, and carried out laminating unification.
[0089] Example 2Nz pasted up 1/4 wavelength plate of -1.5 on the small spiral pitch side of a polarizing element, and also the optical element and the lighting system were obtained according to the example 1.
[0090] Example of comparison 11 / 4 wavelength plate was pasted up on the small spiral pitch side of a polarizing element, and also the optical element and the lighting system were obtained according to the example 1.
[0091] The wavelength region of the circular dichroism obtained according to example of comparison 2 example 1 by 400-500nm, 450-550nm, 500-600nm, or 600-700nm The left-handed circularly-polarized light is penetrated. Hayes 2% of cholesteric-liquid-crystal layers [four sorts of] After the wavelength region of circular dichroism considers as a cholesteric-liquid-crystal (superposition) layer using the cholesteric-liquid-crystal layer and the 450-550nm cholesteric-liquid-crystal layer which are 400-500nm according to an example 1 first, Exfoliate the cellulose-triacetate film of a side with the large spiral pitch, and the wavelength region of circular dichroism carries out superposition processing of the cholesteric-liquid-crystal layer and the 600-700nm cholesteric-liquid-crystal layer which are 500-600nm at the order of a spiral pitch according to the above by the method which sticks a liquid crystal layer to the surface of separation. By 125nm, the spiral pitch difference of the thickness direction obtained the optical element and the lighting system according to the example 1 using it, after obtaining the polarizing element which consists of a four-layer cholesteric-liquid-crystal layer of superposition which shows circular dichroism in a 400-700nm wavelength region.
[0092] Hayes of the cholesteric-liquid-crystal (superposition) layer which forms the polarizing element obtained in the evaluation examination Hayes example and the example of comparison was investigated (the Nippon Denshoku Industries make, NDH-20D).
[0093] The degree of polarization in the outgoing radiation light of the lighting system obtained in the degree-of-polarization example and the example of comparison was investigated.
[0094] The polarizing plate has been adjusted and arranged to the degree of axial angle which shows the maximum brightness at the optical outgoing radiation side of the lighting system obtained in the degree example of improvement in brightness, and the example of comparison, the brightness of the direction of a transverse plane was investigated (the TOPCON CORP. make, BM-7), and it asked for the degree of improvement in brightness by the rate at the time of setting to 100 the transverse-plane brightness in the state where there is no optical element.
[0095] While having adjusted and arranged the polarizing plate to the degree of axial angle which shows the maximum brightness at the optical outgoing radiation side of the lighting system obtained in the viewing-angle property example and the example of comparison and investigating the color change by viewing-angle change, from the polarizing plate top, visual observation investigated display nonuniformity and the viewing-angle property was evaluated.
[0096] The aforementioned result was shown in the following **.

	ヘイズ (%)	偏光度 (%)	輝度向上度	視角特性
実施例1	2	90	155	良好
実施例2	2	89	154	良好
比較例1	2	89	154	不良
比較例2	12	88	148	普通

Drawing selection drawing 1

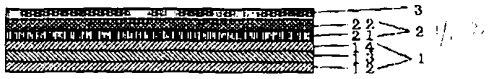
[Translation done.]

Drawing selection drawing 2



[Translation done.]

Drawing selection drawing 3



[Translation done.]

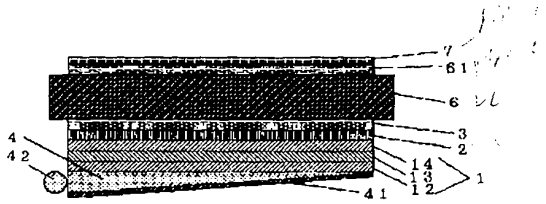
Drawing selection drawing 4

[Translation done.]

Drawing selection drawing 5

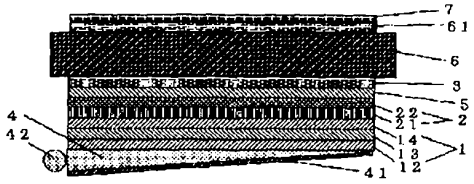
[Translation done.]

Drawing selection drawing 6



[Translation done.]

Drawing selection drawing 7



[Translation done.]